

UNCLASSIFIED

AD NUMBER
AD100889
CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Controlling DoD Organization... Naval Ordnance Laboratory, White Oak, MD.
AUTHORITY
U.S. NOSE ltr, 23 Apr 1970; USNSWC ltr, 4 Dec 1974

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

AD 100889

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION ALEXANDRIA, VIRGINIA

CLASSIFICATION CHANGED

TO UNCLASSIFIED

FROM CONFIDENTIAL

AUTH: U.S. NOGE

LETTER DATED 23 APRIL 70



UNCLASSIFIED

UNCLASSIFIED

AD100889

Armed Services Technical Information Agency

Reproduced by

DOCUMENT SERVICE CENTER

KNOTT BUILDING, DAYTON, 2, OHIO

This document is the property of the United States Government. It is furnished for the duration of the contract and shall be returned when no longer required, or upon recall by ASTIA to the following address: Armed Services Technical Information Agency, Document Service Center, Knott Building, Dayton 2, Ohio.

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.



UNCLASSIFIED

This document is the property of the United States Government. It is furnished for the duration of the contract and shall be returned when no longer required, or upon recall by ASTIA to the following address:
Armed Services Technical Information Agency, Arlington Hall Station,
Arlington 12, Virginia

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

~~CONFIDENTIAL~~

NAVORD REPORT

4

AD No. 100889

ASTIA FILE COPY

SENSITIVITY OF SOME ALUMINIZED EXPLOSIVES TO BULLET IMPACT

FC

29 DECEMBER 1955



U. S. NAVAL ORDNANCE LABORATORY

WHITE OAK, MARYLAND

JUL 26 1957

~~CONFIDENTIAL~~

56AA

3355

AD 100 889

ASTIA Document Service (5cc

CONFIDENTIAL U. S. NAVAL ORDNANCE LABORATORY

WHITE OAK
SILVER SPRING, MARYLAND



To all holders of NAVORD Report 4199
insert change; write on cover 'Change 1 inserted'
Approved by Commander, U.S. NOL

Change 1

1 page

J. E. Abland
By direction

is changed as follows:

1. Under B. Explosive Container - change perpendicular to read parallel

Insert this change sheet between the cover and the title page of your copy.

CONFIDENTIAL

MAY 15 1957

57AA

25686

SENSITIVITY OF SOME ALUMINIZED EXPLOSIVES
TO BULLET IMPACT

By:
Harry Heller

Approved by:

R. Stinson for R. McGill
Russell McGill, Chief
Explosives Properties Division

ABSTRACT: Tests designed to investigate the bullet sensitivity of various explosive compositions are described in this report. The work done by the Explosives Properties Division at the Naval Ordnance Laboratory with the object of gaining general information concerning the mechanical sensitivity of the explosives tested is collected here. The results are summarized in a table in which four classes of bullet sensitivity are established. While the work was of an exploratory nature, it appears possible to draw the following conclusions.

(a) Sensitivity to bullet impact of the explosives tested depends to a great extent on its physical state (cast, pressed, loose) with cast explosive being more sensitive than pressed.

(b) The percent and degree of detonations obtained are dependent in large measure on the degree of confinement. In this respect the mass of the explosive is important since the body of the explosive may serve to increase the degree of confinement.

(c) The use of incendiary in place of ball ammunition greatly increases the chances of high order detonation.

CONFIDENTIAL
NAVORD Report 4199

(d) There was no detectable change in the sensitivity of H-6 with a 134°F change in temperature, -65 and + 70°F.

(e) A great number of tests are necessary before any reliance can be placed in the data since the test is statistical in nature.

EXPLOSIVES RESEARCH DEPARTMENT
U. S. NAVAL ORDNANCE LABORATORY
White Oak, Silver Spring, Maryland

CONFIDENTIAL

NAVORD Report 4199

29 December 1955

The results of bullet sensitivity tests for some explosive compositions have been collected and summarized. This work is only a part of the larger topic of the sensitivity of explosives to mechanical impact with which we are concerned. All explosive compositions used were prepared by the Explosives Properties Division. Mr. F. O. Canter and Mr. G. W. Reynolds, Physical Science Aids, gathered all the data used in this report. This investigation was authorized by Task B2c-21-1-56. Due to the statistical nature of this type of test and the need for further work before more definite conclusions could be reached, this report is issued for information only and is not intended as a basis for action.

JOHN T. HAYWARD
Captain, USN
Commander


J. E. ABLARD
By direction

CONFIDENTIAL
NAVORD Report 4199

CONTENTS

	<u>Page</u>
APPARATUS AND PROCEDURE -----	1
A. Weapon	1
B. Explosive Container	1
C. Ammunition	1
D. Classification of Results	2
REFERENCE -----	8

ILLUSTRATIONS

TABLE I	Tabulated Results of Bullet Sensitivity Tests--	3
Figure I	Interior of the Gun House with Gun in Firing	
	Position -----	5
Figure II	View of the Interior of the Bombproof with Pipe	
	Nipple in Firing Position -----	6
Figure III	Overall View of the Gun House, Bombproof and	
	Baffle Tunnel -----	7

CONFIDENTIAL
NAVORD Report 4199

**SENSITIVITY OF SOME ALUMINIZED EXPLOSIVES
TO BULLET IMPACT**

APPARATUS AND PROCEDURE

A. Weapon

The weapon used in the tests was a Browning Machine Gun, Cal. 0.50, HB M2, Ground, with its tripod secured to a concrete block. The gun was housed in a concrete building provided with bulletproof windows and an opening for the gun. The gun house faces a concrete bombproof shelter lined with thick steel plates. The samples under test were placed on the floor of the bombproof directly in back of a small opening which faces the gun house. A wooden tunnel containing metal baffles was interposed between the bombproof and the gun house to minimize the escape of metal fragments and insure that the few that did escape would be stopped by the gun house.

Figures 1 through 3 show views of the gun house with the gun in firing position, the bombproof with a test sample in firing position and the overall arrangement of the gun house, bombproof and baffle tunnel.

B. Explosive Container

All the tests were made with explosives loaded into standard 2" I. D. x 3" closed-nipples of cast steel. Caps were 1.5" x 2" and a wall thickness of 0.25 inches. When cast explosives were used the nipple was completely filled and then capped at one or both ends by empty caps. With pressed explosives two pellets were used which filled the nipple completely and the empty caps screwed on as before. Unless otherwise noted all bullets are assumed to have entered the nipple perpendicular to the cylinder axis and evenly centered. Where there was evidence that the bullet did not hit on center the result was discarded. When only one cap was used the bullet was fired into the open end of the nipple.

C. Ammunition

The bullets used in the tests were all 50 Cal. ball M-2 ammunition unless otherwise noted.

CONFIDENTIAL
NAVORD Report 4199

D. Classification of Results

An attempt was made to classify the results so they would conform to the classification used by other experimenters, reference (a), in order that data from tests made on the same or similar explosives might be compared. The test results were classified as follows:

1. I - Inert, damage to nipple no greater than that caused by bullet itself. *
2. EL - Low order, some flash, smoke, noise and deformation of container - unconsumed explosive may be recovered either from the container or the ground.
3. EM - Mild explosion, violent noise with marked damage to container and absence of unconsumed explosive.
4. EH - High explosion, violent noise, flash, smoke and the nipple completely shattered into small fragments with no trace of solid explosive.

In classifying the data into the four categories shown above, the experience and bias of the observer assumes great importance. In order to insure that the data be as consistent as possible two men collaborated in observing the results of the tests. The data on the explosives that have been tested in accordance with the procedures outlined above are tabulated in Table 1.

It would be convenient if bullet impact data could be correlated with results of the drop-weight impact test for the same explosives. This does not seem possible because the results of the bullet test are very sensitive to the physical state and degree of confinement of the explosive while the drop-weight test results are much less dependent on these variables. An example of the extreme variation between the two tests is the behavior of Comp C-4. In the drop-weight test it is more than twice as sensitive as TNT while in the bullet test TNT has a much greater sensitivity than Comp C-4.

*Nipples loaded with inert material were tested in order to differentiate damage caused by the bullet alone.

CONFIDENTIAL
NAVORD Report 4199

TABLE 1
TABULATED RESULTS OF BULLET SENSITIVITY TESTS

Explosive (or Mixture)	Loading	Container (Nipple + One or Two Caps) Shots	No. of	I	EL	EM	EH
TNT	Cast	1 Cap	10	5 50%	5 50%	0%	0%
TNT	Cast	2 Caps	10	0%	0%	0%	10 100%
TNT	Pressed	1 Cap	10	2 20%	1 10%	7 70%	0%
TNT	Pressed	2 Caps	10	1 10%	2 20%	7 70%	0%
TNT/A1 (40/60)	Cast	1 Cap	10	0%	1 10%	4 40%	5 50%
TNT/A1 (40/60)	Cast	2 Caps	10	0%	0%	0%	10 100%
TNT/A1 (40/60)	Pressed	1 Cap	12	0%	0%	12 100%	0%
TNT/A1 (40/60)	Pressed	2 Caps	13	0%	0%	11 85%	2 15%
HBX-1 (Nipple and 1 Cap loaded)	Cast	1 Cap	11	0%	0%	0%	11 100%
HBX-1 (Nipple and 1 Cap loaded)	Cast	2 Caps	15	0%	0%	0%	15 100%
HBX-3	Cast	1 Cap	15	0%	0%	2 13%	13 87%
HBX-3	Cast	2 Caps	15	0%	1 7%	0%	14 93%
Comp. B	Cast	1 Cap	13	0%	0%	3 23%	10 77%
Comp. B	Cast	2 Caps	13	0%	0%	0%	13 100%
AP [*] /A1 (85/15)	Pressed	1 Cap	9	0%	4 45%	3 33%	2 22%
AP/A1 (85/15)	Pressed	2 Caps	10	0%	0%	0%	10 100%

* Ammonium Perchlorate

3
CONFIDENTIAL

CONFIDENTIAL
NAVED Report 4199

TABLE 1 (CONT.)
TABULATED RESULTS OF BULLET SENSITIVITY TESTS

Explosive (or Mixture)	Loading	Container (Nipple + One or Two Caps)	No. of Shots	I	EL	EM	EH
AP/A1 (70/30)	Pressed	1 Cap	10	0%	0%	7 70%	3 30%
AP/A1 (70/30)	Pressed	2 Caps	10	0%	0%	0%	10 100%
AP/A1 (70/30)	Pressed	1 Cap	4	0%	1 25%	0%	3 75%
Caliber 50 Incendiary	Pressed	2 Caps	1	0%	0%	0%	1 100%
AP/A1 (70/30)	Pressed	2 Caps	1	0%	0%	0%	1 100%
Caliber 50 Incendiary	Pressed	2 Caps	1	0%	0%	0%	1 100%
AP/A1/TNT (55/27/18)	Cast	1 Cap	10	0%	1 10%	9 90%	0%
AP/A1/TNT (55/27/18)	Cast	2 Caps	10	0%	0%	0%	10 100%
AP/A1/TNT/Comp A (41/26/24/9)	Cast	1 Cap	10	0%	0%	10 100%	0%
AP/A1/TNT/Comp A (41/26/24/9)	Cast	2 Caps	10	0%	0%	10 100%	0%
AP/A1/TNT/Stan.ALOX (50.4/24.8/16.5/8.3)	Cast	1 Cap	8	0%	0%	0%	1 13%
AP/A1/TNT/Stan. ALOX (50.4/24.8/16.5/8.3)	Cast	2 Caps	10	0%	0%	0%	7 70%
AP/A1/TNT/Comp. A3 (44.4/28.2/17.4/10)	Cast	1 Cap	9	1 11%	1 11%	0%	0%
AP/A1/TNT/Comp. A3 (44.4/28.2/17.4/10)	Cast	2 Caps	11	1 9%	1 9%	0%	0%
H-6 (-64°F)	Cast	2 Caps	14	0%	0%	0%	14 100%
H-6 (70°F)	Cast	2 Caps	15	0%	0%	0%	15 100%
Comp C-4 (Density = 1.32)	Pressed	2 Caps	8	2 25%	5 63%	0%	1 12%
Comp C-4 (Density = 1.32)	Pressed	1 Cap	5	4 80%	1 20%	0%	0%

** Stanolind Wax - Alox

4
CONFIDENTIAL

CONFIDENTIAL
NAVORD REPORT 4199

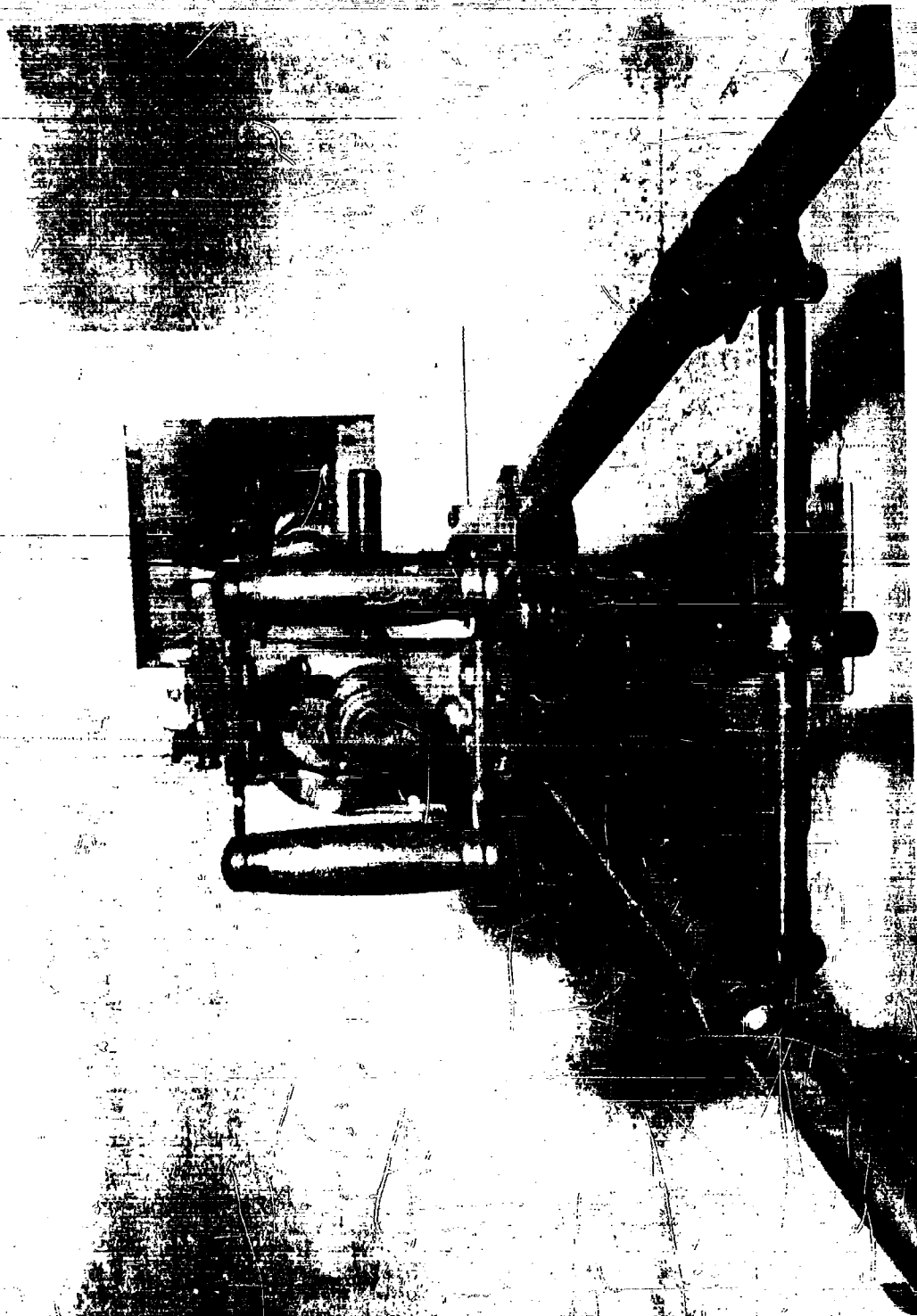


FIG. 1 MACHINE GUN IN FIRING POSITION

CONFIDENTIAL

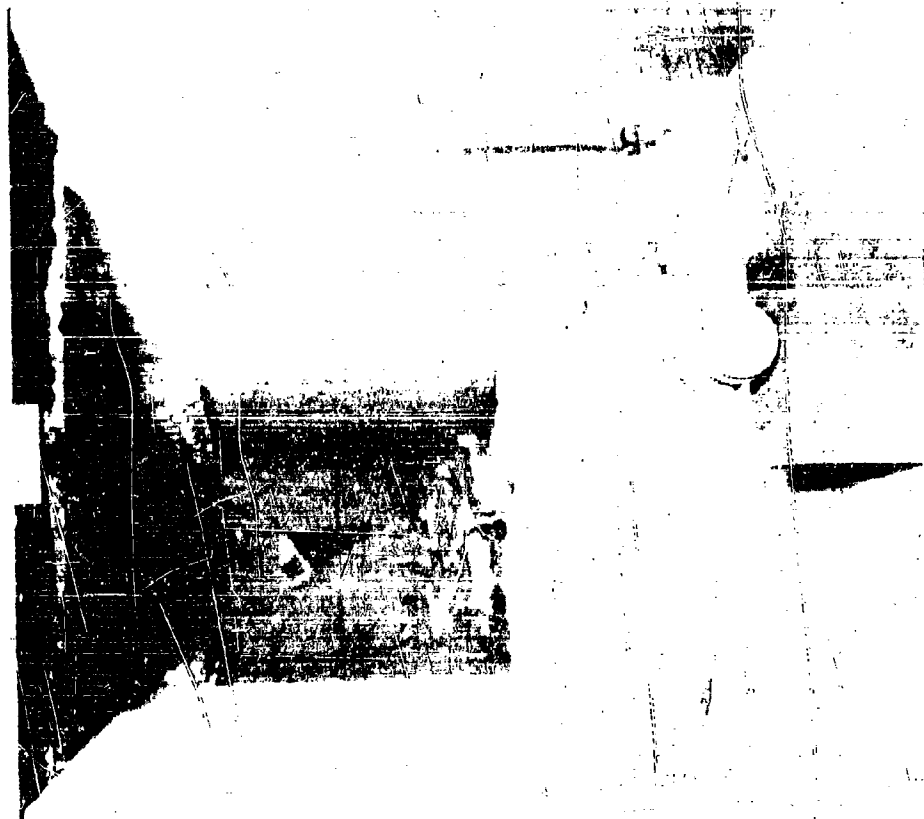


FIG. 2 VIEW FROM INSIDE BOMBPROOF WITH TEST SAMPLE
IN FIRING POSITION

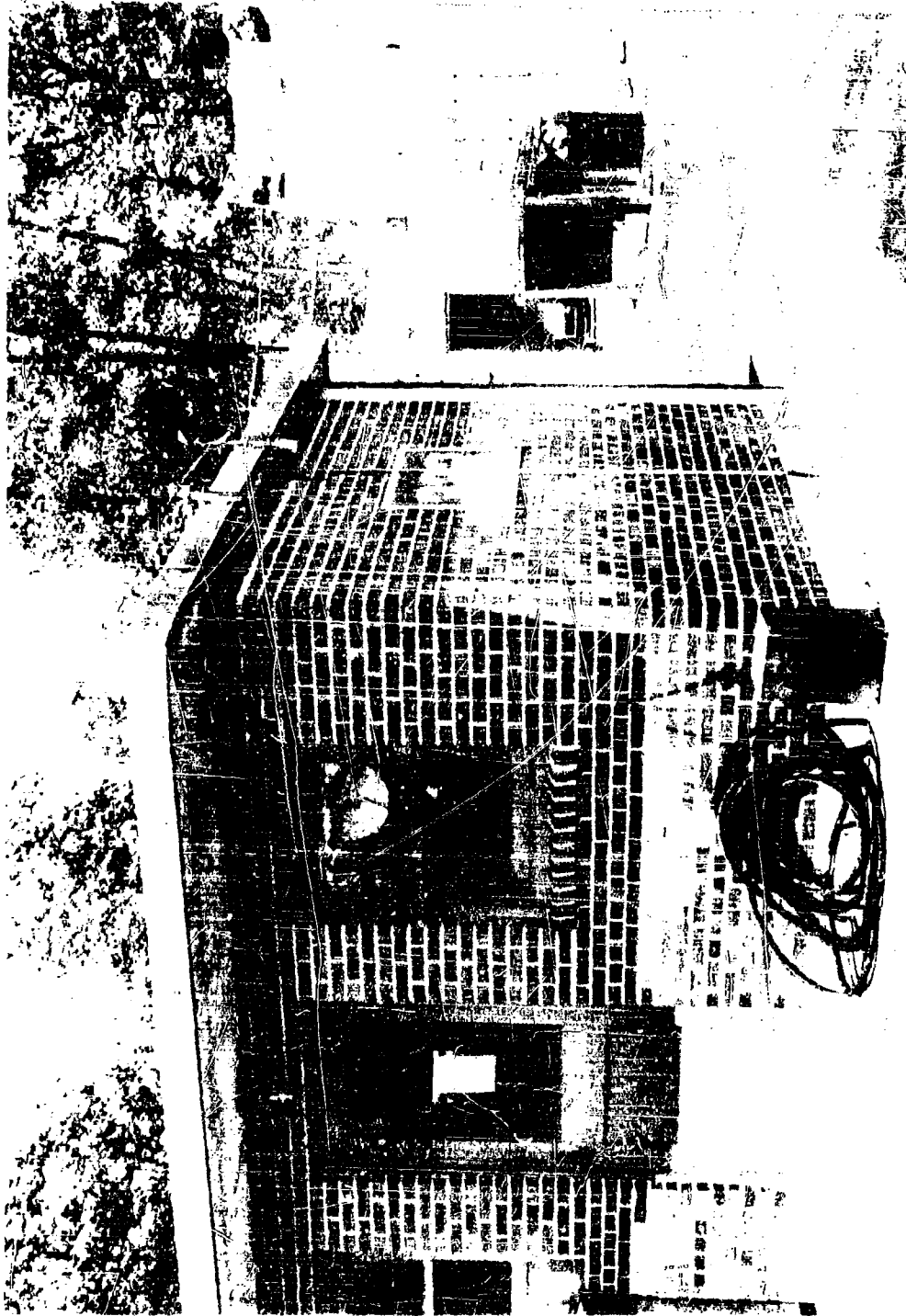


FIG. 3 OVERALL ARRANGEMENT OF THE GUN HOUSE ,
BAFFLE - TUNNEL AND BOMBPROOF

CONFIDENTIAL
NAVORD Report 4199

REFERENCE

- (a) OSRD 3156, Studies of the Sensitivity of Explosives to Bullet Impact, E. H. Eyster, W.H. Rogers, Explosives Research Laboratory, Bruceton, Pa.

CONFIDENTIAL DISTRIBUTION

	<u>Copies</u>
Chief, Bureau of Ordnance (ReU3), Wash., D.C.....	1
Chief, Bureau of Ordnance (Ad3), Wash., D.C.....	2
Director, ASTIA, Document Service Center, Knott Bldg., Dayton 2, Ohio.....	5
Chief of Naval Research, Navy Department, Wash., D.C. Attn: Code 466.....	1
Commander, Naval Proving Ground, Dahlgren, Va.....	2
Commander, Naval Ordnance Test Station, China Lake, Calif., Attn: Library.....	2
Attn: Mr. C. E. Weinland.....	1
Attn: Mr. B. A. Breslow.....	1
Commander, Air Material Command, Wright Patterson Air Force Base, Dayton, Ohio, Attn: WCLGH.....	2
Commanding General, Aberdeen Proving Ground, Aberdeen, Md.....	1
Director, Ballistic Research Laboratories, Aberdeen, Md.....	2
U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.....	2
Office, Chief of Ordnance, Dept. of Army, Research and Development Div., Wash., D.C., Attn: ORDTQ.....	2
Attn: ORDTA, Dr. L. R. Littleton.....	1
Attn: ORDTA, Mr. J. I. Kistle, ORDTA.....	1
Commanding Officer, Picatinny Arsenal, Dover, N. J. Attn: Amm Dev. Br. A, Fuze Sec.....	1
Attn: Amm Dev. Br. B, Bomb, Mine and Grenade Sec.....	1
Attn: Amm Dev. Br. B, Physical Res. Sec.....	1
Attn: Amm Dev. Br. B, Pyrotechnic Sec.....	1
Attn: Amm Dev. Br. B, Chemical Res. Sec.....	1
Attn: Library.....	1
Director, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md., via InsOrd.....	1
Hercules Powder Co., Wilmington 99, Delaware, via InsMat, Attn: Dr. Julius Roth.....	1
Beckman Instruments Inc., Pasadena, Calif., via InsMat Attn: Dr. D. D. Taylor, Jr.....	1
Diamond Ordnance Fuze Laboratories, Conn. Ave., and Van Ness St., Wash., D. C., via InsMat Attn: Mr. Milton Lipnick, Sec. 30.4.....	1
Attn: Mr. Richard Weingrad, Sec. 30.4.....	1
Attn: Mr. Samuel Kolodny, Sec. 30.3.....	1
Attn: Mr. George Keehn, Sec. 30.1.....	1
Attn: Mr. Leo Rubionowitz, Sec. 20.2.....	1

CONFIDENTIAL

DISTRIBUTION

	<u>Copies</u>
Atlas Powder Co., Reynolds Experimental Laboratory, Tamaqua, Pa., via InsMat, Attn: Mr. McGirr.....	1
Olin-Mathieson Chemical Corp., East Alton, Ill., via InsMat, Attn: Mr. R. L. Womer.....	1
Eastman Kodak, Rochester 4, N. Y., via InsOrd, Attn: Mr. John Haas.....	1
Commanding General, Frankford Arsenal, Phila., Pa....	1
Rohm and Haas Co., Redstone Arsenal, Research Div., Huntsville, Ala., Attn: Dr. R. M. Ross, via InsMat	1
Franklin Institute Laboratories for Research and Development, Phila. Ordnance District, via InsMat Phila., Pa.....	1
Los Alamos Scientific Laboratory, Los Alamos, N. M., via InsMat, Attn: Dr. D. P. MacDougall.....	1
Attn: Dr. L. C. Smith.....	1
National Northern, West Hanover, Mass., via InsMat, Attn: Mr. S. J. Porter.....	1
Commanding Officer, Naval Mine Depot, Yorktown, Va., Attn: Research and Development Laboratory.....	2
Commanding Officer, Naval Powder Factory, Indian Head, Md.....	1
University of Washington, Seattle 5, Wash., via InsMat. Attn: Paul C. Cross.....	1
A. D. Little Inc., Cambridge 42, Mass., via InsMat, Attn: Dr. C. W. Sauer.....	1
Aerojet General Corp., Azusa, Calif., via InsMat, Attn: Dr. M. H. Gold.....	1
University of Utah, Salt Lake City, Utah, via ONR Branch Office, 1000 Geary St., InsMat San Francisco, Calif., Attn: Dr. Melvin Cook.....	1
Quality Evaluation Laboratory, Army Ammunition Depot, Oahu, T. H., c/o Postmaster, San Francisco, Navy No. 66.....	1
Quality Evaluation Laboratory, U. S. Navy Ammunition Depot, Crane, Ind., Attn: Mr. J. D. DeVault.....	1
Hercules Powder Co., Port Ewen, N. Y., via InsMat, Attn: Mr. Scherrer.....	1
Chief, Bureau of Ordnance (Ad6).....	1
University of California Radiation Laboratory, Livermore, California, Atomic Energy Commission, San Francisco Operations Office, 1518 Seventeenth Street, Oakland, California.....	2